TECHNICAL MEMORANDUM:
REASONABLE WORST CASE ANALYSIS
TERRESTRIAL RESOURCES

ALCOA (POINT COMFORT) / LAVACA BAY NATIONAL PRIORITIES LIST SITE

REASONABLE WORST CASE (RWC) ANALYSIS
TERRESTRIAL RESOURCES

1.0 Potential Terrestrial Habitat Injuries/Service Losses

Terrestrial habitats addressed in this injury assessment of the Alcoa (Point Comfort) / Lavaca Bay National Priorities List Site (site) are upland habitats that begin where high marsh vegetation occurs and include all surrounding uplands on the mainland and dredge islands (i.e., islands formed from dredge material in the bay). Habitat maps were generated as part of the Remedial Investigation (Alcoa, 1997). The food webs associated with terrestrial habitats generally connect herbivores and detritivores (associated with the soils, plants and detrital material) with carnivores and scavengers. Some of the types of services that are provided by terrestrial resources and habitats that can be affected by contaminants and/or remedial activities include:

X **Food and Productivity:** In natural systems, the terrestrial community includes numerous plants and lower trophic level organisms that are highly productive and serve as food sources for higher level organisms. Herbivores feed on the plants and are subject to predation. Insects, worms and other soil, or detrital, feeders serve as food for insectivores and other predators. There are several levels of carnivorous reptiles, mammals and avians present at the site and in surrounding areas.

X **Habitat Structure:** The plant community provides various structures that several species depend on for reproductive activities, shelter, perching/roosting sites, etc. While many species use habitat structure for nesting and shelter, predators often use it as perches from which to spot prey. The plant community also holds moisture in the soils, prevents erosion and otherwise protects, or enables, other habitat functions.

X **Decomposition and Nutrient Cycling:** Members of the microbial community and other organisms contribute to the decomposition and decay of organic matter and debris. The process of decomposition is important in carbon and nutrient cycles through the terrestrial food web.

X **Recreational Use:** Avians and mammals provide various recreational services to humans. Several avian and mammalian resources are subject to recreational hunting. Various fur-bearers are subject to trapping. An ever-increasing recreational activity is the viewing of wildlife, especially bird watching.

Terrestrial resources provide critical ecological services, which affect nearly all organisms within the ecosystem. Adverse impacts on terrestrial resources have the potential to impact biota in nearly all trophic levels of the area ecosystem. Terrestrial ecosystems on developed lands can have lowered ecological value depending on how the type of development and use of the land influences terrestrial resources. Industrial, commercial, residential and agricultural uses can have varying effects on the ecological functions within a terrestrial ecosystem. Terrestrial resources may provide recreational, as well as ecological, services. Avian and larger mammalian resources

are the subject of recreational observation and hunting activities. However, this property has limited hunting opportunities. Bird watching is a growing recreational activity that is being promoted in the vicinity of this site. These services can be lost through injury to the terrestrial natural resources. These injuries include such adverse effects as direct toxicity, loss of reproductive success, and reduced growth potential.

2.0 Determination of potential service losses

Potential injuries were evaluated for direct exposure to contaminants, the loss of habitat that would result from proposed remedial actions, and the change in recreational use of these resources that could result from these impacts. The effects of contaminant exposure were based on the results of the ecological risk assessment conducted as part of the Remedial Investigation (Alcoa, draft BLRA) for the mainland areas and Dredge Island. The ecological risk assessment determines potential ecological risk for the resources, but does not directly measure injury. Since an ecological risk does not directly indicate that an injury has occurred, the results of the ecological risk assessment would provide a very conservative evaluation of potential service losses for this RWC analysis. Terrestrial habitat loss was quantified from known plans for stabilization of Dredge Island and other specific remedial activities compared to the habitat mapping results.

2.1 Ecological risk assessment

The ecological risk assessment process used information from the Remedial Investigation of the site and other supporting literature to make a qualitative or semi-quantitative assessment of potential risks to ecological receptors. The specific information relied upon in the ecological assessment includes the following:

- X Analytical data collected in the Remedial Investigation documenting the nature and extent of contamination in the terrestrial habitats (Alcoa 2000).
- X Information from the draft ecological risk assessment for terrestrial ecosystems (Alcoa, draft BLRA).
- X Information from the literature on adverse effects of contaminants on the growth, survival and reproduction of the representative species examined.
- X Habitat mapping results for terrestrial habitats of the area (Alcoa, 1997).

A review of the literature identified benchmark concentrations for soil and ingestion for the contaminants of concern that may cause ecological risk (possible service losses) to terrestrial resources. No-observed adverse effect levels (NOAELs) and lowest-observed adverse effect levels (LOAELs) were used to establish toxicity reference values (TRVs), which served as the benchmarks. Based on these benchmarks and concentrations found in environmental site media, potential risks were determined for terrestrial resources. The terrestrial area was divided into units (Potential Source Areas, or PSAs - see the Remedial Investigation Report [Alcoa 2000]) to evaluate risk from contaminant exposure.

The Remedial Investigation for terrestrial areas of the site included nature and extent studies and preliminary assessments comparing contaminant of concern concentrations in soils to screening-

level TRVs for receptor (representative species) exposed to chemicals from direct contact, soil ingestion and/or food chain sources (Table 1). The receptors selected represented various ecological assessment endpoints and habitat uses. Several PSAs were determined to have contaminants exceeding screening levels (benchmarks) and to need evaluation for potential risk to ecological resources. These PSAs were included in the draft ecological risk assessment document (Alcoa, draft BLRA) and this RWC assessment.

Table 1.
Contaminants and exposure pathways in each PSA identified as of concern for terrestrial resources in the baseline ecological risk assessment (Alcoa, draft BLRA).

PSA	Contaminant	Chronic Soil	Chronic Diet	Vegetation
Witco Areas	Mercury, selenium, HPAH	X	X	
Bean Property	Antimony, arsenic, copper, lead, nickel, selenium, zinc	X	X	X
Mainland Shoreline #3	Mercury		X	X
Dredge Island	Mercury		X	X

The draft ecological risk assessment concluded that potential risk exists in several of the PSAs (Alcoa, draft BLRA). Hazard quotients (HQ) greater than 1 in the risk assessment indicate a potential ecological risk is present. The greater the HQ value the higher the risk of injury is. HQs were found to exceed 1 (greater than the TRV value) in the Witco Areas (high molecular weight polycyclic aromatic hydrocarbon - HPAH), Mainland Shoreline #3 (mercury), C.F. Bean Property (arsenic, copper, lead, nickel, selenium and zinc), and the Dredge Island (mercury). Table 2 shows the receptors for which possible risk was indicated in the PSAs, the habitats associated with these receptors and the habitats determined to be present in these areas.

Table 2.

PSAs with possible ecological risk to terrestrial resources (Alcoa, draft BLRA) and the habitats common to these resources and the PSAs are listed.

PSA	Receptor(s)	Receptor Habitats	PSA Habitats
Witco Areas	Avian and mammalian first order carnivores	Woodland, Shrubland, Grassland, High Marsh	Shrubland, Grassland, High Marsh
Mainland Shoreline #3	Plants, detritivores	Woodland, Shrubland, Grassland, High Marsh, Low Marsh	Shrubland, Grassland, High Marsh, Low Marsh
Dredge Island	Detritivores	Varied Upland Habitats	Shrubland, Grassland, High Marsh, Low Marsh
Bean Property	Plants, detritivores, mammalian first order carnivore	Woodland, Shrubland, Grassland,	Shrubland, Grassland

Risk to lower trophic level resources (detritivores and plants) could result in service losses (food) to higher trophic level organisms that feed on them. However, due to the industrial nature of the PSAs, the high reproduction potential of detritivores and plants, and the low risk indicated in the baseline ecological risk assessment, it was decided that service losses associated with these resources were negligible and they would not be carried forward in this assessment. Risk to the higher trophic levels (avian and mammalian carnivores) indicates a potential for greater service losses due to potential impacts to more of the foodweb and to mobile receptors that influence ecosystems over a greater area. The potential service losses due to impacts to these terrestrial resources (Table 3) were assessed and the amount of habitat necessary to restore the service losses to these resources was determined. Using the ecological risk assessment results as indicators of possible service losses is a very conservative evaluation for injury. While this RWC analysis does not precisely quantify injury, its very conservative nature ensures full compensation for any injuries to terrestrial resources.

Table 3.

PSAs and receptors included in the final assessment of service losses for terrestrial resources.

PSA	**Receptor**
Witco Areas	Avian and Mammalian First Order Carnivores
Bean Property	Mammalian First Order Carnivores

2.2 Remedial actions

Remedial actions have been proposed to stabilize and armor the Dredge Island. The actions are to protect the island from erosion and storm damage so materials that have been placed in the disposal lagoons will not be released into the bay. Some of the dredge material has elevated levels of contaminants of concern.

These remedial actions include removing some of the Dredge Island's topsoil and placing armoring rock and dikes over other areas. These actions will remove terrestrial habitats from the island resulting in service losses. From the remedial plans and habitat mapping information it has been determined that about 52 acres of high marsh and 8.6 acres of shrubland/grassland will be lost on the island. The loss of this habitat will be assessed for the amount of habitat necessary to restore future lost services from these terrestrial resources.

2.3 Recreational use

The Trustees also evaluated the potential lost use of terrestrial resources due to a decrease in man's ability to use these resources through normal activities such as hunting and recreational observation. In evaluating the possible loss of recreational hunting services for this site, it has been determined that hunting opportunities do not exist in the terrestrial habitats at present. The terrestrial areas with contaminant levels of concern are privately held and not presently available for public hunting, and have not been hunted in the past. An evaluation of recreational bird watching for the area has found that such activities could exist from along public roads and waterbodies. However, no general access is offered to the property and there are numerous alternative bird watching areas available in close proximity to the site that are of equal or greater value. The potential effects on avian populations are low and probably would not diminish opportunities for this recreational use. Quantifying the potential injury for these human use activities would be very difficult, costly, and likely disproportionate to the amount of potential damages. Also, some, or all, of this potential injury could well be subsumed in restoration options for the other terrestrial injuries. Therefore, the Trustees determined that potential losses for these recreational activities would not be quantified in this assessment.

3.0 Scaling the possible service losses

For terrestrial resources, service losses from contamination occur primarily from direct adverse effects on survival, growth and reproduction of terrestrial populations. These effects can result in shifts in species composition and diversity within the terrestrial community and/or in the overall abundance of organisms. Such shifts can adversely impact the viability and success of the terrestrial ecosystem of the area. Providing similar, or enhanced, terrestrial habitats to those that are critical for the terrestrial resources injured will provide opportunity for increased populations of these resources within the ecosystem. These increases in populations within the terrestrial community will restore any service losses noted.

Direct loss of habitat and services, through the physical alteration, covering or removal of terrestrial habitats as a result of remedial actions can result in temporary or permanent loss. Service losses from this activity were determined from field data on specific remedial activities.

By comparing the habitat needs of the ecological receptors possibly at risk in the PSAs with the habitat types in the PSAs, common habitats appropriate for restoration goals can be determined. Using the habitat maps developed during the Remedial Investigation (Alcoa 1997), photographs of the PSAs and site visits, the habitat types (and their quality) could be evaluated for the various PSAs (Table 2). The Trustees determined that shrubland, grassland and high marsh habitats were common habitat types for the receptors and the PSAs of concern. Projects that provide these habitats in appropriate amounts would address restoration needs for terrestrial resources. Two general habitat types were determined to be the target for restoration projects to meet these goals. Coastal prairie habitats are a combination of shrublands and grasslands that would address the services losses from resources associated with those habitats. Marsh restoration projects would be targeted to address the service losses associated with that habitat type.

Scaling the restoration needs based on the quantity of service losses was difficult for this injury category. The PSAs with contaminants at levels resulting in possible ecological risk are in an active industrial setting with associated disturbances and are managed grasslands that reduce the habitat value and usage of the areas. Additionally, the sampling to screen for risk was undertaken using a method that resulted in sampling only sites expected to have the highest contamination (Alcoa 2000). These sampling locations were normally in industrial areas where a source of a contaminant was known. These locations are characterized, from an ecological perspective, as very low quality habitat as they were highly disturbed areas. The better quality terrestrial habitats on the property probably have much lower contaminant levels with decreased risk since sampling indicates no significant transport pathway for contaminant dispersal into these areas. However, the additional sampling needed to confirm this situation would not likely increase the quantity of service losses assessed. Therefore, the additional expense for such samples is not justified. While hazard quotients in the draft ecological risk assessment did exceed 1, the results did not exceed 1 by substantial amounts. These factors indicate that risk associated with contamination in these terrestrial habitats is relatively minor.

The Trustees are aware that historically these risks could have been greater if higher contamination concentrations were present, especially for mercury. In the past, the PSAs with possible risk were probably less useful to resources due to greater industrial activity at the plant site. When Witco and chlor-alkali processes were operating, the amount and quality of the available habitats in these areas were likely less than now. Therefore, the Trustees believe that historical ecological risks were probably at low levels similar to those under present conditions.

Considering all the factors noted above, the Trustees evaluated the acreage of coastal prairie and high marsh habitats required to compensate for any terrestrial injuries based on this RWC assessment and conservative estimates of service losses. Table 4 lists the acres affected for each PSA, the estimated percent service loss and habitat type used in a habitat equivalency analysis (HEA).

Remedial actions on Alcoa's Dredge Island will cause injuries due to construction to armor and protect the dredge material placement facility. These activities will cause the loss of about 52.02

acres of high estuarine marsh, 2.48 acres of grasslands and 6.14 acres of shrubland habitats. The grassland and shrubland components would equate to 8.62 acres of coastal prairie. Table 4 lists the acres impacted by remedial activities and the ecological risks noted earlier. This information was used in a HEA to determine the number of acres of coastal prairie and estuarine high marsh habitats necessary for terrestrial resource compensation under these very conservative estimates.

Table 4.
The acres affected in each PSA and the percent service losses for interim and remediation losses for each habitat type.

PSA/Habitat Type	Acres Potentially Injured	Interim % loss of service	Perpetual % loss of service
Witco			
Upland Grassland	3.38	10	0
Upland Shrubland	0.72	10	0
Bean Property			
Upland Grassland	7.38	10	0
Upland Shrubland	0.93	10	0
Estuarine Shrubland	1.54	10	0
Dredge Island (After Remediation)			
Upland Grassland	2.48	0	100
Upland Shrubland	6.14	0	100
Estuarine High Marsh	52.02	0	100

4.0 Restoration Strategy

Using this very conservative RWC analysis, the Trustees have determined that possible injuries to terrestrial resources may have occurred at a low level. The additional effort and expense to fully quantify the injuries, other than from remedial impacts, is not warranted. Sufficient terrestrial habitats may be generated when implementing restoration projects for other injured resources to offset the estimated terrestrial service losses. This rationale is explained in more detail later in this section.

The Trustees have determined that the PSAs with possible ecological risk to resources have three common habitat types: high marsh, shrublands and grassland. Restoration projects that provide these habitat types would address the injuries noted. The grassland and shrubland habitats can be combined as one general habitat type for coastal prairie, which is a natural habitat in this region. However, most of the grasslands on the site are managed in a manner consistent with industrial needs, which lowers their habitat quality. The restoration of wetlands is a high priority goal for addressing other injured natural resources at the site (e.g., RWC-Benthos). High marsh and coastal prairie habitats can easily be incorporated into these wetland restoration projects. Therefore, the Trustees have determined that restoration of high marsh and coastal prairie

habitats are the best strategy for addressing terrestrial injuries.

For wetland ecosystems to be fully functional, they have to integrate habitats from open water through low marsh to high marsh and coastal prairies. Without all these habitat components, any coastal wetland restoration project would have lowered functional success compared to natural systems. This is usually addressed by including restoration of these habitats, or establishing elevations and other conditions to allow these habitats to establish themselves naturally. Additionally, shrubland and coastal prairie habitats could be established by returning agricultural land to a natural succession toward prairie and shrubland (e.g., eliminate grazing). By including provisions for these habitats in wetland restoration projects, terrestrial service losses can be restored over time.

Sufficient marsh restoration will be needed to address other injury categories (e.g., benthos) to allow additional habitat to be created to address terrestrial injuries with minimal effort. Marsh restoration projects to address other injury categories could include in their designs provisions for high marsh and coastal prairie habitat types to address terrestrial injuries (e.g., elevation contouring). By providing the opportunity for these habitats to become established with the other wetland restoration efforts, the terrestrial service losses can be restored and the restoration projects will include habitats necessary to achieve a fully functioning wetland community. Low marsh through high marsh and coastal prairie are critical to provide all of the services supplied by these ecological systems. If unforeseen circumstances occur which will not allow developing high marsh and coastal prairie habitats sufficient to address estimated terrestrial service losses, the Trustees will have to reevaluate this approach.

4.1 Restoration option

The proposed low marsh restoration site recommended by the Trustees for restoring benthos injuries is located on the Whitmire tract (owned by Alcoa) and the adjacent unit of the Aransas National Wildlife Refuge. The Whitmire tract is composed of about 729 acres including 370 acres of a shallow freshwater lake, 205 acres of upland coastal prairie and shrubland, 78 acres of freshwater marsh and transitional shrubland, and 60 acres of estuarine marsh and waterbodies (Alcoa 1996). While the low marsh restoration project will use a small portion of the upland acreage, if this project is approved, the remaining area on the Whitmire property will be available to offset the terrestrial injury associated with the site.

As noted above, the preferred habitats for offsetting any terrestrial service losses were determined to be high marsh and coastal prairie. These habitats already exist on the Whitmire property. Acquisition of this property, and placing it in the public trust, protects these habitats from future development. Additionally, a study evaluating the condition of habitats on the Whitmire tract indicates that, while functional, the habitats can be significantly improved by better management practices than were used in the recent past (Alcoa 1999). The acquisition and improved management of this property (enhancement) can restore the terrestrial resources injured at the site.

Historic cattle grazing adversely impacted several of the habitat types present, including high

marsh, grasslands and freshwater marsh habitats (Alcoa 1999). Implementing better management practices will increase the functional value of these habitats for terrestrial resources. Eliminating overgrazing impacts will allow the habitats to diversify and spread offering greater benefit to the terrestrial resources and increased service flows. Areas that are presently bare ground should become vegetated and sensitive species that were restricted in location should expand their range into new locations. Providing improved management practices on the Whitmire property will result in enhancement of service flows from the estuarine high marsh, freshwater marsh and coastal prairie habitats. Incorporating contours, or elevations, allowing upland habitats to develop with the other wetland creation restoration projects will allow even more terrestrial service gains. Preservation of the high marsh and coastal prairie habitats along with the enhancement of these habitats by improved management practices will result in habitat service gains.

The acquisition of the Whitmire tract will directly protect more upland habitat than that directly lost through remedial actions. The information provided in Table 4 and the estimates of service gains for the Whitmire property were used to calculate the number of acres of habitat required to compensate for all the terrestrial injuries. The results of the HEA indicate that for this very conservative assessment the equivalent of about 10.2 acres of coastal prairie habitat and 54.3 acres of high marsh habitat need to be acquired, preserved and/or enhanced for the restoration project to successfully compensate for the terrestrial injuries.

The Whitmire property includes approximately 60 acres of estuarine marsh (low and high marsh), 78 acres of freshwater marsh, 205 acres of upland habitats (coastal prairie and shrubland) and 370 acres of shallow freshwater reservoir (Alcoa 1996). The estuarine and freshwater marshes provide many similar service flows to the terrestrial resources impacted. The freshwater lake provides additional service flows to the terrestrial resources that were affected. Freshwater sources are often limited in coastal areas and are very important for terrestrial resources. The acquisition, preservation and enhancement of 138 acres of estuarine and freshwater marsh and 205 acres of coastal prairie habitats clearly compensates for the conservative estimate of service losses for terrestrial resources. The additional gains from the freshwater reservoir and high marsh that result from the planned marsh restoration project add even more compensation.

The service gains from acquiring, preserving and enhancing the Whitmire property likely provide more compensation than is necessary to compensate for possible terrestrial service losses. The service gains from acquisition, improved management of the property (enhancement), and gains associated with other wetland creation projects offer sufficient restoration to offset possible service losses associated with terrestrial resources at the site. If the Whitmire site restoration project proposed to compensate for benthic resource injuries is not selected, similar terrestrial habitats and service flows will have to be considered for a different project to address the possible terrestrial service losses.

5.0 Literature Cited

Alcoa. Draft. Baseline Risk Assessment Report. Alcoa (Point Comfort)/Lavaca Bay Superfund Site. Point Comfort, Texas. February 2000.

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